(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 880 942 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
02.12.1998 Bulletin 1998/49

(51) Int. Cl.[6]: **A61B 17/60**

(21) Application number: **98109079.8**

(22) Date of filing: **19.05.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.05.1997 IT VR970042**

(71) Applicant: **ORTHOFIX S.r.l.**
37012 Bussolengo (VR) (IT)

(72) Inventors:
- **Faccioli, Giovanni**
  46040 Monzambano, Mantova (IT)
- **Venturine, Daniele**
  37065 - Povegliano Veronese, Verona (IT)

(74) Representative:
O'Byrne, Daniel Joseph
c/o Fenzi & Associati,
25, Via Saval
37124 Verona (IT)

(54) External minisplint device

(57) An external minisplint device comprises an elongated body (2) which supports at least one pair of clamps (3, 4; 3', 4'; 103, 104) each of which is capable of securing at least one pair of transverse bone bolts (F), longitudinal guide means (5, 5', 105, 106) associated with the elongated body to guide the longitudinal translational movement of at least one of the clamps (4, 4'; 103, 104), at least one longitudinal adjustment screw (6, 6', 107, 108) which can rotate within the elongated body and which engages a corresponding threaded hole (13) formed in the clamp capable of translational motion for selectively positioning it along the longitudinal guide means, the screw having a head (7, 7') which partly projects from the end of the elongated body, means for axially immobilising the adjustment screw when it is rotated. The axial immobilising means comprise at least one smooth key, and preferably a pair of smooth gauged keys (15, 15', 19, 110) inserted in the elongated body in tangential contact with the base of a circular groove (17) formed in the head (7) of the adjustment screw (6).

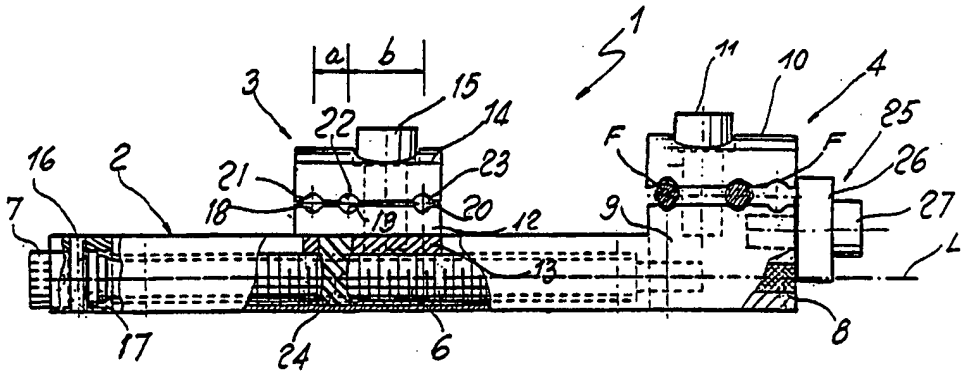

Fig. 1

EP 0 880 942 A2

Description

Field of application

This invention finds application in bone surgery and in the treatment of fractures or deformations of small bones, for example of the hand or foot, or in maxillofacial surgery, and relates in particular to a minisplint of the type which is both fixed and articulated.

State of the art

Compact fixation devices of the abovementioned type, for example that of the fixed type described in Italian patent no. 1,183,736 and that of the articulated type described in US patent no. 4,604,997, which include all the features described in the precharacterising clause of claim 1, are known.

These known minisplint devices effectively perform the task required of them but are susceptible of some improvements.

In fact, both the minisplint devices mentioned above have at least one clamp which can move with respect to a longitudinal support by means of an adjustment screw in which the said screw is axially immobilised with respect to the support by a washer which is retained by one recessed end or by means of a locking pin. However these immobilising systems have little strength in the axial direction, and can deform or break very easily, and also show excessive play.

Secondly, the clamps have only two seats for the bone bolts which are located symmetrically with respect to a tightening screw, with a minimum distance which may be excessive for small bones, and which in any event is not always an optimum distance.

Furthermore, the opposing half-cylindrical seats formed by the clamps only make it possible to securely hold bolts or Kirschner wires of a single diameter.

Another disadvantage lies in the limitation of the effective travel of the movable clamp due to the fact that the slide of the latter cannot run to the end of the longitudinal guide groove.

Finally, in the case of an articulated clamp, the rotating joint has a fixed limb which is of excessive size on the side of the securing head, and therefore a different device must be used for mounting on each side of the bone. Finally, the relative angle formed between the two parts connected by the joint is adjusted manually and approximately, and not micrometrically.

Description of the invention

The main purpose of this invention is to avoid or at least diminish the disadvantages complained of above.

A particular intention is to provide an external minisplint device which guarantees reliable, stable and accurate positioning of the movable clamps.

Another intention is to provide an external minisplint device by means of which bone bolts of different diameters can be reliably secured at variable minimum distances.

A further intention is that of providing a bilateral minisplint, i.e. one which can be readily fitted on both sides of a fracture.

Yet a further intention is to provide a minisplint with an axial joint by means of which the angle formed by its rotating parts can be adjusted micrometrically.

These objectives and yet others which will become clearer below are accomplished by a device according to claim 1, characterised in that it provides means for axially immobilising the adjustment screw comprising at least a smooth gauged key inserted in the clamp support arranged so as to act tangentially together with a circular groove formed towards one end of the adjustment screw.

Preferably the said circular groove is formed in the head of the adjustment screw. In addition to this, two gauged keys which are substantially parallel and symmetrical with respect to the adjustment screw may be provided in order to act with opposing parts thereof.

These securing means ensure a high resistance to stresses and minimum play in the axial direction.

Each clamp comprises a base and a cover, which can be coupled together by means of a locking screw, having corresponding transverse seats for at least three longitudinally offset bone bolts.

Advantageously the abovementioned seats have an approximately semi-elliptical shape in cross-section so that bone bolts of different diameters can be accepted.

Furthermore, one of the abovementioned seats is located opposite the other two with respect to the adjustment screw and the distance between the two seats on the same side is less than the distance between the two seats on opposite sides with respect to the locking screw.

The base of each transversely movable clamp has on the underside a key which is able to slide in a longitudinal groove of complementary shape formed in the support in order to provide the said guide means.

The threaded hole is constructed in the abovementioned lower appendage which houses an insert of elastomer material with a central hole of a diameter which is slightly less than that of the adjustment screw, in order to exert an anti-loosening braking effect on the latter.

The support may comprise a one-piece bar of substantially rectangular shape at one end of which is provided a projection defining the base of one of the clamps.

At the other end of the bar provision may be made for a spherical joint with means for securing the base of one of the clamps in a predetermined position.

As an alternative, the support may be formed of two terminal bars articulated by means of a central axial joint with a transverse axis of rotation in which a movable pin is provided which can be inserted from either

side with respect to the centre of the joint in order that the device may be fitted bilaterally.

Brief description of the figures

Further features and advantages of the invention will become apparent from the description of some preferred but not exclusive embodiments of the minisplint devices according to the invention which are illustrated by way of example and not restrictively through the appended table of drawings in which:

Figure 1 shows a side view of a first embodiment of the minisplint device according to the invention,

Figure 2 shows a view from above of the minisplint device in Figure 1,

Figure 3 shows a side view of a second embodiment of the minisplint device according to the invention,

Figure 4 shows a view from above of the minisplint device in Figure 3,

Figure 5 shows a side view of a third embodiment of the minisplint device according to the invention,

Figure 6 shows a view from above of the minisplint device in Figure 5,

Figure 7 shows a side view of a fourth embodiment of the minisplint device according to the invention,

Figure 8 shows a view from above of the minisplint device in Figure 7,

Figure 9 shows a side view of a fifth embodiment of the minisplint device according to the invention,

Figure 10 shows a view from above of the minisplint device in Figure 9,

Figure 11 shows a side view of a sixth embodiment of the minisplint device according to the invention,

Figure 12 shows a view from above of the minisplint device in Figure 11.

Description of some preferred embodiments

With reference to Figures 1 and 2, an external minisplint device according to the invention, indicated as a whole by reference number 1, is illustrated, and essentially comprises an elongated body 2 which supports a pair of claims 3, 4 for bone bolts F.

Elongated body 2 preferably comprises a bar of approximately rectangular shape having a longitudinal axis L. Body 2 has a longitudinal groove 5 which extends over a good part of its length and defines longitudinal guide means for at least one of the clamps, in particular clamp 3.

Clamp 3 can be moved along groove 5 by means of an adjustment screw 6 which is rotatably supported in two end holes in body 2 in line with longitudinal axis L. Adjustment screw 6 has a recessed hexagon head 7 for an Allen key which projects from the end of body 2. The end hole opposite head 7 of screw 6 is closed off by means of a plug 8 of elastomer material to avoid the build-up of impurities and the risk of infections.

Fixed clamp 4 comprises a base 9 which is integral with body 2 and a cover 10 which is connected to base 9 by means of a locking screw 11 which also has a recessed hexagon head.

Movable clamp 3 also has a base 12 with a lower appendage or key 13 of a width slightly less than that of groove 5 so that it can slide freely along it. In lower appendage or key 13 there is a threaded hole which is engaged by adjustment screw 6. The longitudinal ends of key 13 have rounded ends so that they can be inserted into the ends of complementary shape in key 13* so as to increase the useful travel of movable clamp 3.

Covers 10, 14 respectively are anchored on bases 9, 12 of clamps 4, 3 by means of corresponding locking screws 11, 15 which have recessed hexagon heads.

In accordance with the invention, adjustment screw 6 is immobilised axially with respect to elongated body 2 by means of a smooth gauged pin 16 which is inserted in a transverse hole in the body itself and is designed to engage tangentially with a circular recess 17 formed in the head of adjustment screw 6 allowing it to rotate about its longitudinal axis L.

Preferably two pins 16, 16' are provided on opposite sides of head 7 of adjustment screw 6 in a substantially symmetrical arrangement parallel to axis L.

As a result of the substantial force exerted by pin 16, screw 6 is axially immobilised in an extremely secure and reliable way and without any risk of breakage even when very high stresses are applied. Furthermore, given the fact that the key is made to dimensions with extremely small tolerances the play in the rotatable coupling is minimum, unlike the situation in the past, thus allowing micrometer adjustment of the movement of the clamp.

In order to increase the flexibility with which the clamps can be used, three transverse seats for the same number of bone bolts are provided on each of these instead of the two normally present in the clamps in the past.

For simplicity only the seats in clamp 3 will be described below, it being understood that the seats in clamp 4 are absolutely identical.

Three transverse grooves which are parallel to

[* Sic - T.]

each other, indicated respectively by 18, 19, 20, are provided on the upper face of base 12 of clamp 3, while a similar number of grooves 21, 22, 23 are provided in cover 14 in corresponding positions.

When the two sets of grooves are coupled together the transverse cross-section resulting from the seats for the bolts is approximately elliptical and not circular, in order to provide secure immobilisation of bolts of different diameters of for example between 2 mm and 5 mm.

In addition to this, the spacing between grooves 18 and 19, or between grooves 21 and 22, and the same part of locking screw 15 is equal to approximately half the distance b between grooves 19 and 20, or between grooves 22 and 23, on opposite sides with respect to screw 15, so that three different spacings are possible. In fact, if distance a is 4 mm and distance b is 8 mm, two bone bolts can be fitted with spacings of 4 mm, 8 mm or 12 mm.

It is desirable that an insert 24 of elastomer material, for example Teflon®, having a central hole for adjustment screw 6 and having an internal diameter which is slightly less than the external diameter of screw 6 is provided in the lower part of key 13 of movable clamp 3 to exert an anti-loosening braking effect on the latter.

A further clamp for transverse bone bolts anchored to body 2 at the end adjacent to fixed clamp 4 may also be provided and this is indicated in general by reference number 25. In particular clamp 25 may comprise a forked stirrup 46 with an approximately U-shaped transverse cross-section with three pairs of opposing grooves provided on the inner faces of the stirrup to hold the bone bolts. The stirrup may be anchored to the end face of base 9 of body 2 by means of a screw 27 which is also used to tighten the opposing faces of the stirrup against the bone bolts.

Figures 3 and 4 illustrate an articulated minisplint indicated generally by 1' which comprises an elongated body 2' in the shape of a rectangular bar connected to an arm 28 by means of an axial joint which is indicated as a whole by reference number 29. Elongated body 2' has a longitudinal groove 5' and an adjustment screw 6' which is axially immobilised by means of a pair of keys 16, 16'. Arm 2" is connected to an expansion 9' which forms the base of clamp 4'.

In particular, axial joint 29, of a type which is in itself known, is formed of a pair of eyes 30 between which the end of arm 28 is inserted. The two parts are hinged together by means of a pin 31 whose axis H is substantially parallel to the seats of the clamps of the bone bolts.

Desirably pin 31 has a head 32 with a recessed hexagon, a smooth central portion 33 and a threaded end 34 onto which is screwed a lock nut 35. Thus the pin can be unscrewed and its position reversed to reduce the size of the joint on the side adjacent to the bone, thus making the fixation right handed or left handed according to requirements.

Articulated fixation 1" shown in Figures 5 and 6 differs from that in Figures 3 and 4 essentially in the fact that the axis V of axial joint 36 between elongated body 2" and arm 37 is substantially perpendicular to the seats of the clamps for the bone bolts. Body 2" slidably supports clamp 3" which can move through the agency of an adjustment screw 6" which is axially immobilised by means of a pair of gauged pins 16".

Articulated clamp 1"' illustrated in Figures 7 and 8 differs from those in Figures 3 to 7 in that connecting joint 37 between bar 2"' and arm of clamp 4"' is of the spherical type. In particular, joint 37 comprises a pair of jaws 39 with a hemispherical cavity for a ball 40 formed on arm 39 connected to base 9"' of clamp 4"'. Jaws 39 can be tightened against ball 40 by means of a locking screw 41 so as to lock the orientation of clamp 4"'. The latter is shaped in such a way that the seats of clamp 4"' for the bone bolts are located in a plane which is substantially parallel to the longitudinal axis of the said clamp.

Spherical joint minisplint device 1^{IV} illustrated in Figures 9 and 10 differs from that in Figures 7 and 8 essentially in the fact that the seats of clamp 4^{IV} for the bone bolts are located in a plane which is substantially perpendicular to the longitudinal axis of the clamp.

Figures 11 and 12 illustrate an articulated minisplint device indicated as a whole by reference number 100 which comprises two elongated bodies 101, 102 of slightly different lengths which slidably support clamps 103, 104 which can be moved along longitudinal grooves 105, 106 by means of corresponding adjusting screws 107, 108. Again in this case adjustment screws 107, 108 are axially immobilised against the corresponding bars by means of smooth gauged pins 109, 110 which act together with circumferential grooves made in heads 111, 112 of the screws.

The two elongated bodies 101, 102 are joined together by means of a joint 113 whose axis K is substantially parallel to the seats of the clamps for the bone bolts.

For accurate and micrometer adjustment of the angle β formed between the two bodies 101, 102 there is provided an actuator 114 having screws with an opposing thread acting on the ends of the bars adjacent to joint 111.

In particular this actuator essentially provides two forks 115, 116 formed towards the adjacent ends of bodies 101, 102 which are capable of rotatably housing corresponding cylindrical blocks 117, 118. A bar 119 has ends 120, 121 which are threaded in opposite directions and which engage corresponding holes with opposing threads in cylindrical blocks 117, 118, and a central cylindrical expansion 122 with transverse holes 123 for the introduction of an adjustment key. Obviously by rotating threaded bar 114 pairs of stirrups 112, 113 are caused to move together or move apart with a consequent micrometric change in the angle β formed between the two elongated bodies 101, 102.

In use, all that is necessary is to insert the bolts or Kirschner wires into the bone stumps at suitable distances corresponding to the spacings between the clamps, and then immobilise the clamps on the free ends of the bolts and finally bring about lateral movement of the clamps and positioning of the elongated bodies and arms supporting the clamps so as to set the fracture or correct deformation.

Claims

1. External minisplint, comprising an elongated body (2) which supports at least one pair of clamps (3, 4; 3', 4'; 103, 104) each of which is capable of securing at least one pair of transverse bone bolts, longitudinal guide means (5, 5'; 105, 106) associated with the said elongated body to guide the longitudinal translational movement of at least one (4, 4'; 103, 104) of the said clamps, at least one longitudinal adjusting screw (6, 6'; 107, 108) which can rotate within the said elongated body and engages a corresponding threaded hole formed in the said movable clamp to position it selectively along the said longitudinal guide means, the said screw (6, 6'; 107, 108) having a head (7, 7') which partly projects from one end of the said elongated body and means for axially immobilising the said adjustment screw in its rotation, characterised in that the said axial immobilising means comprise at least one smooth elongated key in tangential contact with the base of a circular groove (17) formed in the said adjustment screw.

2. Minisplint device according to claim 1, in which the said circular groove (17) is formed in the head (7) of the said adjustment screw (6).

3. Minisplint device according to claim 1, in which the said axial immobilising means comprise a pair of smooth transverse pins (15, 15', 19, 110) which are substantially parallel and placed on opposite sides of the said adjustment screw.

4. Minisplint device according to claim 1, in which each clamp (3, 4) comprises a base (11, 8) and a cover (14, 9) which can be coupled together by means of a locking screw (10, 15) and which are provided with corresponding transverse seats (18, 19, 20; 21, 22, 23) for at least three longitudinally offset bone bolts, the said seats having an approximately semi-elliptical transverse cross-section so as to receive bone bolts of different diameters.

5. Minisplint device according to claim 4, in which one of the said seats (20, 23) is placed on the side opposite the other two (18, 21; 19, 22) with respect to the said locking screw (15), with the spacing (a) between the two seats on the same side being less than the spacing (b) between the two seats on the opposite side with respect to the locking screw.

6. A minisplint device according to claim 1, the base (11) of each movable clamp having on the underside a key (13) which can slide in a correspondingly shaped longitudinal groove (5) formed in the said support and forming the said guide means.

7. Minisplint device according to claim 6, in which the said key (13) has a rounded end of a shape complementing the ends of the said longitudinal groove (5) so as to increase the useful travel of the movable clamp.

8. Minisplint device according to claim 6, in which the said threaded hole (13) is made in the said key (13), and in which the said key houses an insert (24) of elastomer material with a central hole of diameter slightly less than that of the said adjustment screw (6) to exert an anti-loosening braking effect on the latter.

9. Minisplint device according to claim 1, in which the said support (2) comprises a single-piece bar of substantially rectangular shape at one end of which there is formed as an integral piece the fixed base (8) of one of the said clamps.

10. Minisplint device according to claim 9, in which the outer face of the said integral base has movable anchorage means for an additional clamp for transverse bolts.

11. Minisplint device according to claim 12, in which the said additional clamp comprises a U-shaped stirrup with seats for bolts substantially perpendicular to the longitudinal axis of the support, in which the opposing faces of the said stirrup can be moved towards the outer face of the said integral base by means of a locking screw.

12. Minisplint device according to claim 9, in which the base (36) of one of the said clamps is connected to one end of the said bar (2') by means of a spherical joint (33) provided with locking means (34, 37) to orientate the clamp in a predetermined direction.

13. Minisplint device according to claim 1, in which the said support is formed of two bars (2', 2") which are articulated together by means of an axial joint (25; 25'; 111) with a transverse axis, the said bars being provided with corresponding longitudinal guide means.

14. Minisplint device according to claim 13, in which the ends of the said end bars adjacent to the said joint are connected by an actuator with counterthreaded

screws (116, 117) to adjust the angle of inclination of the said bars (101, 102) in a longitudinal plane perpendicular to the axis of the joint.

15. Minisplint device according to claim 13, in which the said axial joint has a pin (28, 28') which can be removably inserted between the sides with respect to the midline of the joint in order to permit the device to be fitted bilaterally.

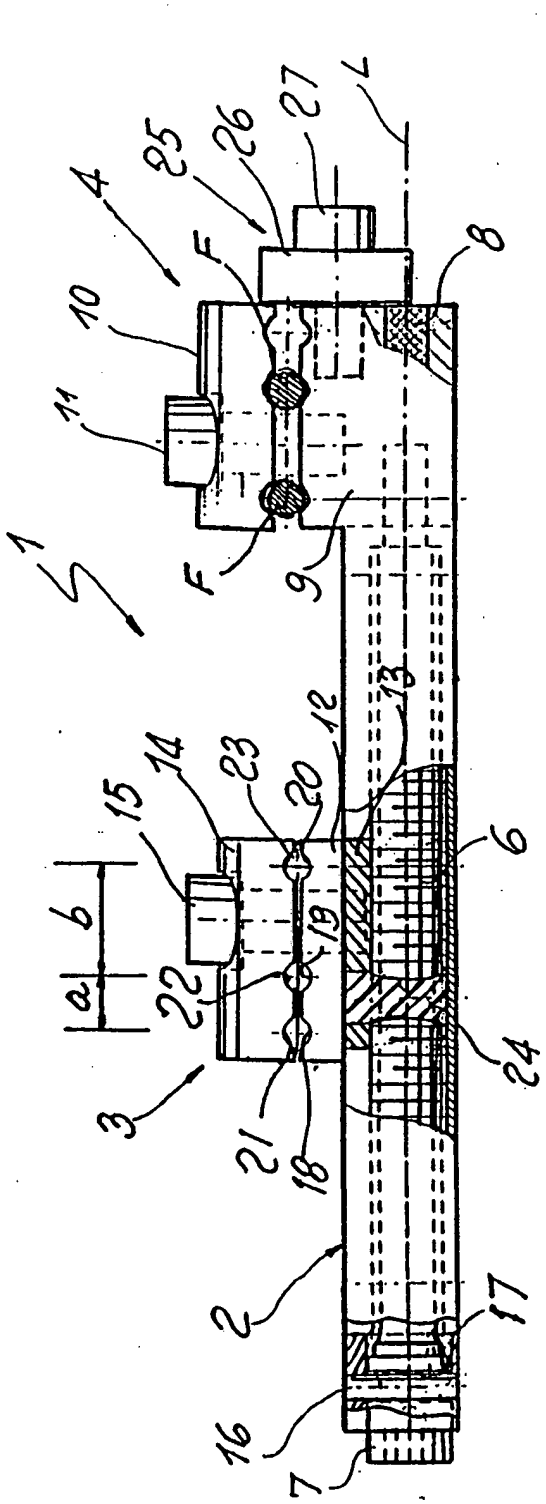
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
F
L
a
b

Fig. 1

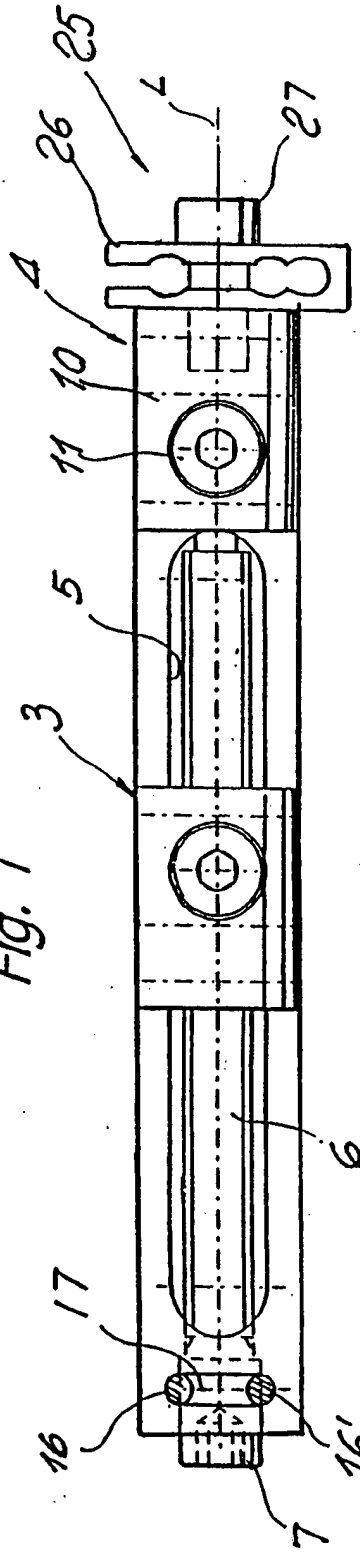
3
4
5
6
7
10
11
16
16'
17
25
26
27
L

Fig. 2

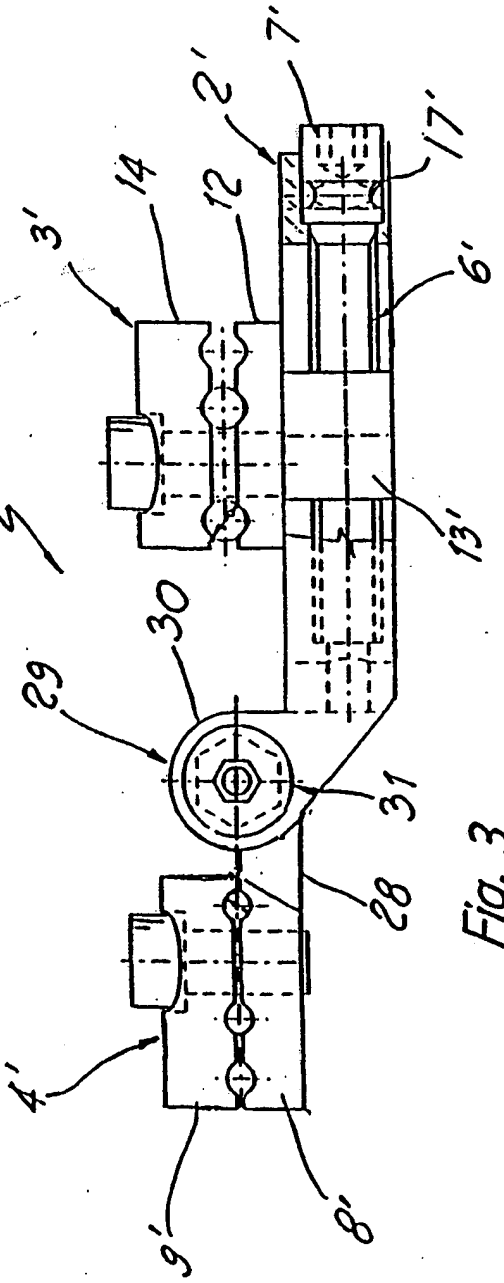

Fig. 3

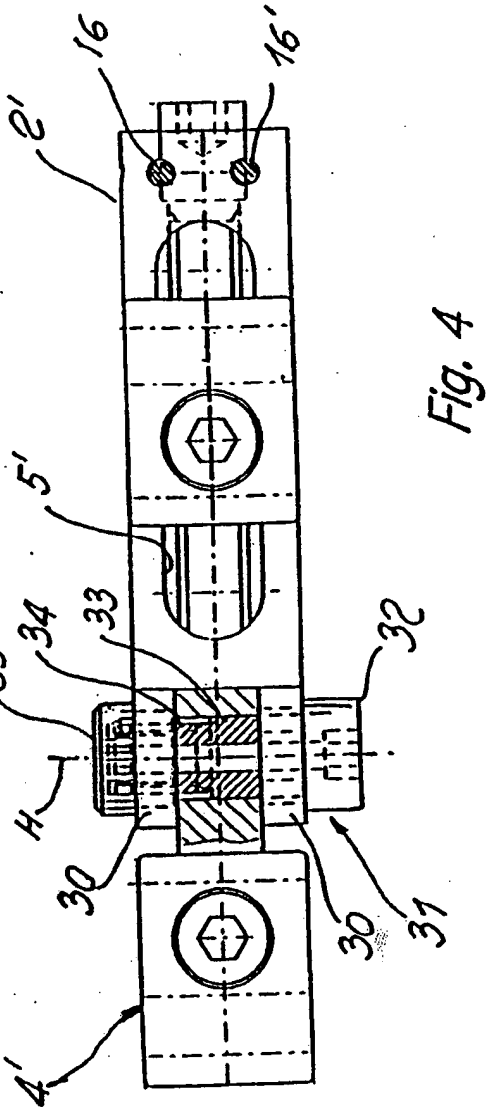

Fig. 4